ROAD CONDITIONS MONITORING. ACTUAL AND UNDERGOING RESEARCH METHODS

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REZUMAT. Starea carosabilului reprezinta o problema foarte importanta in traficul rutier deoarece influenteaza pe de o parte siguranta rutiera atat a participantilor la trafic si a vecinatatii soselelor (cladiri, indicatoare, gradini) , cat si a vitezei medii de deplasare si a fluentei circulatiei. Cresterea continua a numarului de autoturisme depaseste adeseori capacitatea de proiectare a infrastructurii rutiere, provocand astfel aglomerari, si crescand riscul producerii de accidente. Monitorizarea starii carosabilului se poate face atat prin metode optice,cat si prin senzori fixati in sosea.

Cuvinte cheie: conditii de drum , detectie , monitorizare , senzori , metode optice

ABSTRACT. The roadway state is a very important issue in traffic because it influence on the part of both road safety and road users in the vicinity of roads (buildings, signs, gardens), on the other hand has a rather large influence on the average travel speed and fluency. Increasing number of cars often exceeds the design capacity of the road infrastructure, causing crowding, and increasing the risk of accidents. Road condition monitoring can be done either through fixed sensors in the road, or remotely by optical methods or by monitoring weather conditions and water detection under the road.

Keywords: road condition, detection, monitoring, sensors, optical methods.

1. INTRODUCTION

Trying to continually optimize safety and comfort of people in cars and reduce costs in terms of fuel consumption and increase vehicle performance is the number of electronic systems in vehicles to increase continuously. Also try by increasing passenger safety and reduce the risk of involvement in motor vehicle accidents.

In traffic, currently there are a lot of risk factors, with various causes such as weather, road conditions, traffic conditions, technical condition of the vehicle, the health of driver distraction driving by some events (talking on cell phone, GPS programming, search a particular radio frequency).

More accurate knowledge of road conditions is important for drivers to adapt leadership style to them and to the author for taking measures of any fixes, if any, or the issuing of warnings.

Road condition monitoring can be done using a number of sensors specially designed to be installed in asphalt, so its upper part to be in the roadway.

The surface condition of roads is of great concern to road

authorities and road maintenance people. During the winter months it is especially important to be informed of the changing surface conditions to enable road maintenance personnel to take the proper course of action. By knowing the road conditions, the use of antiicing chemicals may be optimized and in many cases reducing maintenance cost.

2. “IN ROAD” SENSORS

This type of sensors measures up to four important parameters:

- o Road temperature
- o Wet or dry road surfaces
- o Salinity of the surface moisture, from which the freezing point is calculated
- o Snow or Not Snow

The location of these sensors is especially in areas where there is a high enough probability that the road to settle dew or frost to form. Given that the sensor is mounted so that it is built into the road, a number of disadvantages result of its use, which may include a number of risks:

- o The risk that the sensor is destroyed when passing vehicles, in the event of landslides due to vibration or falling objects on the road
- o The risk that the information provided by the sensor is not quite real due to unevenness of state roads all over it, as can be seen from the figures below
- o Information provided by the sensor refers strictly to the point where it is located so as to monitor a larger area, it takes a large number of sensors.

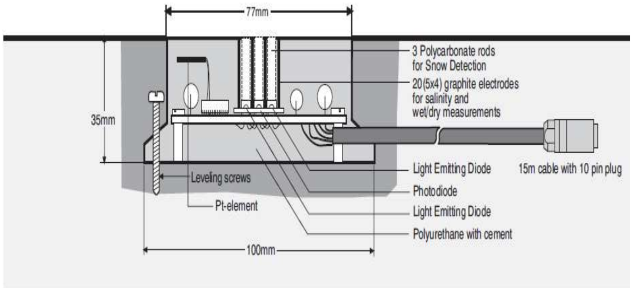

Fig. 1. Road state sensor

The temperature sensing element is a platinum resistor. The salinity measurement is based on the four electrode principle. A constant alternating current is applied to the two outer electrodes in each set. If water is present, the two inner electrodes measure a voltage dependent on the concentration of salt. This conductivity measurement is temperature compensated which gives a salinity measurement. These measurements are taken every second and averaged over the sampling interval. The average value indicates the freezing point.

The Wet/Dry Detector also uses an electrode to sense the voltage on the sensor surface. If the surface is wet, it will detect a voltage created by the salinity circuitry.

The Snow Detector is based on optical detection of light transmitted by two light emitting diode. When snow is present, the light from the LED is reflected by the snow and detected by a photodiode.

Fig. 2. Uniform surface in terms of road conditions

The sensor is mounted in the pavement such that its upper part is flush with the pavement in an area where water is not accumulated. Sensor supply and data transmission is via a cable length 15 m, the weather station of the road.

Another type of monitoring road conditions from the one shown above, with sensors mounted in asphalt, is the remote, which uses video cameras. Detection using video cameras can be made using polarized light, or using infrared cameras.

Fig. 3. Surface uneven in terms of road conditions

3. OPTICAL METHODS

The following are the two methods for detection of wet and icy surfaces.

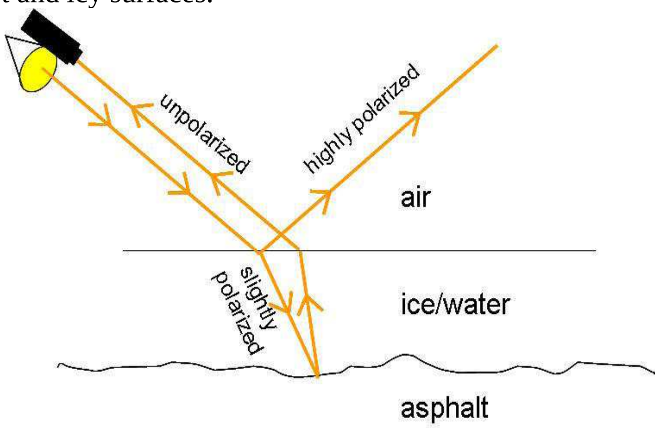

Fig. 4. Detection using polarized light

For this method has the robustness problem, but it is relatively cheap (2000 Eur).

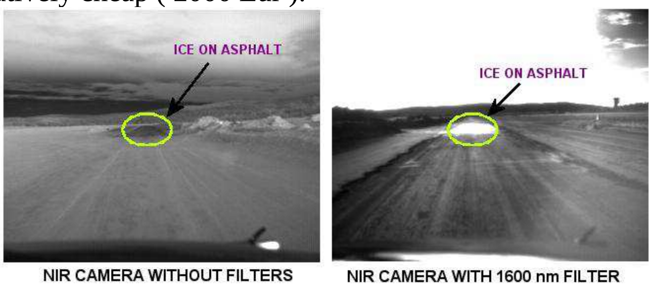

Fig. 5. Detection using NIR band

This method is reliable for ice and snow detection , but it is expensive (7000 Eur).

Water and ice reflect electromagnetic radiation differently. In the first figure below we can see the difference between water and ice reflectivity at wavelengths between 0.5-2.5 um.

In the second picture below can be observed the differences between the 3-wavelength reflections in situations when pavement is dry, wet, snow covered or icy.

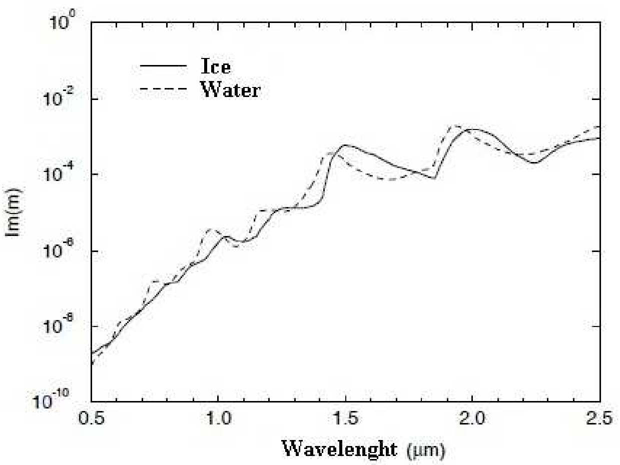

Fig. 6. Reflection ice and water

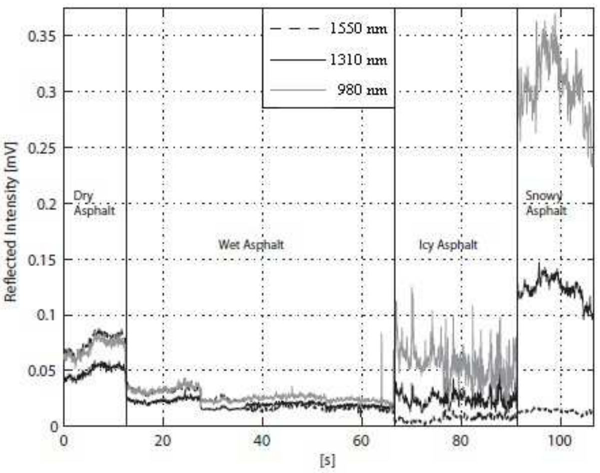

Fig. 7. Dry, wet, icy and snowy asphalt reflection

4. ROAD FRICTION COEFFICIENT

Weather conditions affect the roadway for a shorter or longer time and traffic conditions are influenced by the roadway. This water, either in liquid, solid form, or both, the road surface, greatly alter the coefficient of friction between the tire and the road. Reducing friction coefficient has the effect of increasing the risk of skidding and increase braking distance.

Friction is the resistance to motion between two surfaces in contact. Its value is expressed by the coefficient of friction (f), which is in a ratio of two forces, one parallel to the contact surface and opposing the movement (friction force) and the other perpendicular to the force (normal force) .

In road transport, the contact surface interface consists of tire-wear, while the normal force corresponding to the load on the wheel.

The friction coefficient values range from about 0 on a ice clothing to more than one in the best conditions.

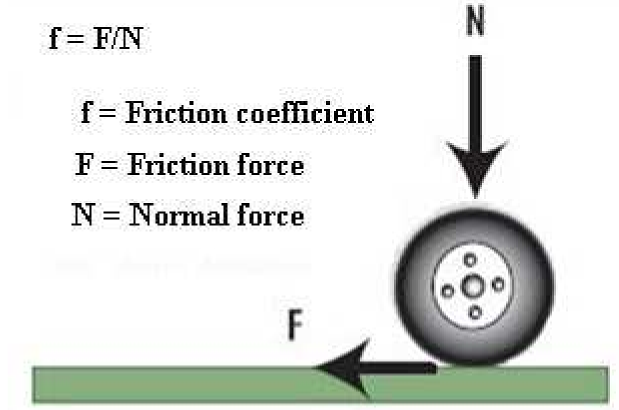

Fig. 8. Friction coefficient

The values of the friction coefficient for different types of surfaces are shown in the table below:

Surface type	Dry		Wet	
	< 50 km/h	> 50 km/h	< 50 km/h	> 50 km/h
Beton: new	**0.8 – 1.2**	**0.7 – 1**	0.5 – 0.8	0.4 – 0.75
normal	0.6 – 0.8	0.6 – 0.75	0.45 – 0.7	0.45 – 0.65
moulding	0.55 – 0.75	0.5 – 0.65	0.45 – 0.65	0.45 – 0.6
Asphalt: new	**0.8 – 1.2**	**0.65 – 1**	0.5 – 0.8	0.45 – 0.75
normal	0.6 – 0.8	0.55 – 0.7	0.45 – 0.7	0.4 – 0.65
moulding	0.55 – 0.75	0.45 – 0.65	0.45 – 0.65	0.4 – 0.6
Excess of bitum	0.5 – 0.6	0.35 – 0.6	0.3 – 0.6	0.25 – 0.55
Gravel: compacted	0.55 – 0.85	0.5 – 0.8	0.4 – 0.8	0.4 – 0.6
non compacted	0.4 – 0.7	0.4 – 0.7	0.45 – 0.75	0.45 – 0.75
Crushed stone	0.55 – 0.75	0.55 – 0.75	0.55 – 0.75	0.55 – 0.75
Smooth ice	**0.1 – 0.25**	**0.07 – 0.2**	**0.05 – 0.1**	**0.05 – 0.1**
Snow: compacted	0.3 – 0.55	0.35 – 0.55	0.3 – 0.6	0.3 – 0.6
non compacted	**0.1 – 0.25**	**0.1 – 0.2**	0.3 – 0.6	0.3 – 0.6

Table 1

As can be seen from the above table the coefficient of friction when surfaces covered with ice and water, is 20 times lower than for a surface covered with new asphalt dry.

5. PRESENT RESEARCHES

Currently being researched in the context of a PhD thesis, is studied a method of detecting road conditions by measuring the asphalt temperature using an infrared temperature sensor, air temperature, humidity about 25 cm ground level and 1.5 m, and using an ultraviolet radiation source. Asphalt temperature measurement using an infrared temperature sensor, type Melexis 90614, measuring temperature from a distance with a field of view of 90 degrees, with an accuracy of 0.02 degrees. This sensor interfacing with microcontroller system is extremely simple considering that the sensor is digital, and transmit information via the I2C protocol. To measure air humidity at 25 cm from the pavement and 1.5 m, using two temperature-humidity sensors, digital Maxdetect produced by the company that communicates with the microcontroller through 1-wire bus protocol. Knowing the values of air temperature, air humidity and temperature of the road, you can easily identify situations on the road can make dew naturally.

$$t_{pr}(t, H_{rel}) = T_n \cdot \frac{\ln(\frac{H_{rel}}{100\%}) + \frac{m \cdot t}{T_n + t}}{m - [\ln(\frac{H_{rel}}{100\%}) + \frac{m \cdot t}{T_n + t}]} \quad (1)$$

t_{pr} - dew point temperature [ºC]

t - air temperature [ºC]

H_{rel} - relative humidity [%]

m - 17.62

T_n - 243.12 ºC

In addition to temperature and humidity sensors, the system uses a UV radiation source, wavelength 390 nm, and a UV sensitive photodiode.

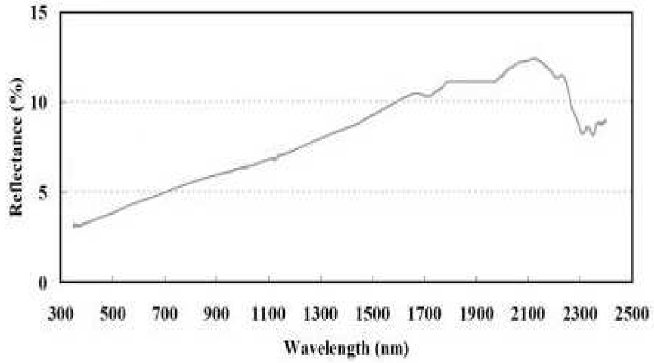

Fig. 9. Asphalt reflection for different wavelength

As can be seen in the figure above, asphalt reflection in the ultraviolet is the weakest.

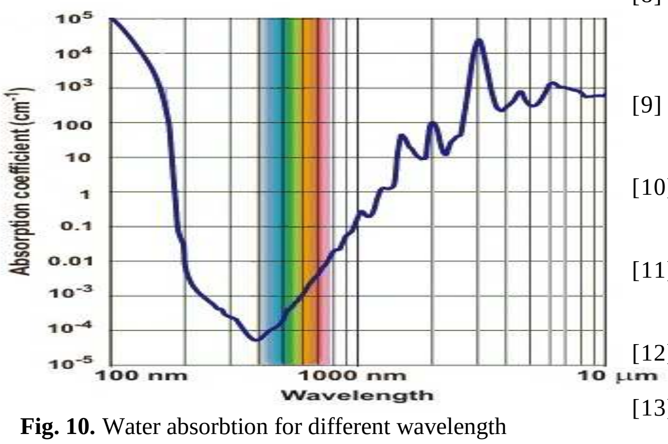

Fig. 10. Water absorbtion for different wavelength

As can be seen from the figure below, the absorption coefficient of water is minimal in the wavelength close to 400 nm.

6. CONCLUSIONS

Considering the the current research, we could say that in addition to current methods of monitoring road conditions will also appear method that uses as input parameters the system temperature, humidity at different values of the distance from the road, the road temperature and reflected radiation in the ultraviolet region.

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